

IN THE CLAIMS:

- 1 1. (Original): A policer based on Random Early Detection (RED), comprising:
 - 2 a filter that determines a filtered virtual time debt; and
 - 3 a control law circuit that receives the filtered virtual time debt from the filter and
 - 4 determines whether a packet should be dropped.
- 1 2. (Original): The RED policer of claim 1, wherein a virtual time debt uses a time T in which a packet is expected to arrive and is computed using a predetermined output transmission rate.
- 1 3. (Original): The RED policer of claim 2, wherein predetermined output transmission rate is given by a traffic contract.
- 1 4. (Previously Presented): The RED policer of claim 1, wherein the filter is based on an exponential weighted moving average (EWMA) virtual time delay using the expression,
 - 3
$$EWMA_k = (1-g)EWMA_{k-1} + g(VTD)_k,$$
 - 4 where k indicates the presently received packet, and k-1 indicates the last packet
 - 5 received, the virtual time debt (VTD) is computed by the expression: $VTD = T(\text{packet}$
 - 6 $\text{expected to arrive}) - T(\text{packet actually arrives}),$ and g is the gain of the filter.
- 1 5. (Original): The RED policer of claim 1, further comprises a sampler that samples a virtual time debt at a sampling interval, and transmits the sampled virtual time debt to the filter.

- 1 6. (Original): The RED policer of claim 1, further comprises:
 - 2 a random generator that generates a number based on the control law circuit's de-
3 termination as to whether a packet should be dropped; and
 - 4 a counter that is set with the number generated by the random generator, wherein
5 the counter counts packets passing through the RED policer up to the set number, and
6 wherein the RED policer drops a packet when the counter has counted out the set num-
7 ber.
- 1 7. (Original): The RED policer of claim 6, further comprises:
 - 2 the control law circuit that determines a probability of a packet being dropped
3 based on the filtered time debt exceeding a predetermined minimum threshold, and speci-
4 fies a range of numbers based on the probability; and
 - 5 the random generator that randomly generates a number in the range specified by
6 the control law circuit.
- 1 8. (Original): A policer based on Random Early Detection (RED), comprising:
 - 2 means for determining a moving average of a virtual time debt; and
 - 3 means for determining whether a packet should be dropped based on a value of
4 the moving average of the virtual time debt.
- 1 9. (Original): The RED policer of claim 8, further comprises means for sampling a vir-
2 tual time debt at a sampling interval, and transmitting the result to the moving average
3 determining means.
- 1 10. (Original): The RED policer of claim 8, further comprises:

2 means for generating a random number based on the result of the packet dropping
3 means; and

4 means for counting a number of packets passing through the RED policer up to
5 the random number generated by the random number generating means, wherein the
6 RED policer drops a packet when the counting means has counted out the generated ran-
7 dom number.

1 11. (Original): A network device comprising:

2 a plurality of Random Early Detection (RED) policers, wherein each RED policer
3 includes,

4 a filter that determines a filtered virtual time debt; and
5 a control law circuit that receives the filtered virtual time debt from the fil-
6 ter and determines whether a packet should be dropped; and
7 a packet classifier that determines which packet should go to which RED policer.

1 12. (Previously Presented): A method of policing packets in a network device, the
2 method comprising the steps of:

3 determining a filtered virtual time debt of a traffic;
4 comparing the filtered virtual time debt with a predetermined minimum threshold;
5 and if the filtered virtual time debt exceeds the minimum threshold, then
6 generating a random number that is used to determine which packet should be
7 dropped.

1 13. (Original): The method of claim 12, wherein generating a random number further
2 comprises the steps of:

3 generating the random number in a range based on a level by which the filtered
4 virtual time debt exceeds the minimum threshold;
5 setting a counter with the random number; and
6 dropping a packet when the counter has counted out the random number.

1 14. (Previously Presented): A computer readable medium having instructions contained
2 therein, which when executed by a computer performs a method comprising the steps of:
3 determining a filtered virtual time debt of a traffic;
4 comparing the filtered virtual time debt with a predetermined minimum threshold;
5 and if the filtered virtual time debt exceeds the minimum threshold, then
6 generating a random number that is used to determine which packet should be
7 dropped.

1 15. (Original): The medium of claim 14, wherein generating a random number further
2 comprises the steps of:
3 generating the random number in a range based on a level the filtered virtual time
4 debt exceeds the minimum threshold;
5 setting a counter with the random number; and
6 dropping a packet when the counter has counted out the random number.

1 16. (Previously Presented): Electromagnetic signals propagating over a computer net-
2 work, said electromagnetic signals carrying instructions for execution on a processor for
3 the practice of the method comprising the steps of:
4 determining a filtered virtual time debt of a traffic;

5 comparing the filtered virtual time debt with a predetermined minimum threshold;
6 and if the filtered virtual time debt exceeds the minimum threshold, then
7 generating a random number that is used to determine which packet should be
8 dropped.

1 17. (Previously Presented): A method of policing packets in a network device, the
2 method comprising the steps of:

3 determining a virtual time debt of packets flowing through the network device;
4 and

5 determining whether a packet should be dropped based on the virtual time debt of
6 the packets.

1 18. (Previously Presented): The method as in claim 17, further comprising: determining
2 that a packet should be dropped when a virtual time debt threshold has been reached.

1 19. (Previously Presented): The method as in claim 17, further comprising: determining
2 a moving average of the virtual time debt.

1 20. (Previously Presented): The method as in claim 17, further comprising: calculating
2 the virtual time debt as the difference between a time a packet is expected to arrive and a
3 time the packet actually arrives.

1 21. (Previously Presented): The method as in claim 20, further comprising: calculating
2 the time a packet is expected to arrive according to a traffic contract.

1 22. (Previously Presented): The method as in claim 17, further comprising: sampling the
2 virtual time debt at a sampling interval.

1 23. (Previously Presented): The method as in claim 17, further comprising:
2 generating a random number;
3 counting a number of packets passing through the network device up to the ran-
4 dom number; and
5 dropping a packet when the counted number reaches the random number.

1 24. (Currently Amended): A method of policing packets in a network device, the
2 method comprising the steps of:

3 determining a virtual time debt of packets flowing through the network device,
4 the virtual time debt computed as a positive delay from an expected packet arrival time
5 established by a traffic contract to an actual packet arrival time;

6 determining that packets should be dropped when the virtual time debt of the
7 packets exceeds a predetermined value; and if so

8 choosing a packet to be dropped, the chosen packet in response to a random num-
9 ber; and

10 dropping the chosen packet.

1 25. (Previously Presented): The method as in claim 24, further comprising:

2 generating the random number

3 counting a number of packets passing through the network device up to the ran-
4 dom number; and

5 dropping a packet when the counted number reaches the random number.

1 26. (Currently Amended): A policer, comprising:

2 means for determining a virtual time debt of packets flowing through the network
3 device, the virtual time debt computed as a positive delay from an expected packet arrival
4 time established by a traffic contract to an actual packet arrival time;

5 means for determining that packets should be dropped when the virtual time debt
6 of the packets exceeds a predetermined value; and if so

7 means for choosing a packet to be dropped, the chosen packet in response to a
8 random number; and

9 means for dropping the chosen packet.

1 27. (Previously Presented): A computer readable media, the computer readable media
2 containing instructions for execution in a processor for the practice of the method com-
3 prising the steps of:

4 determining a virtual time debt of packets flowing through the network device;
5 and

6 determining whether a packet should be dropped based on the virtual time debt of
7 the packets.

1 28. (Previously Presented): Electromagnetic signals propagating on a computer network,
2 the electromagnetic signals carrying instructions for execution in a processor for the prac-
3 tice of the method comprising the steps of:

4 determining a virtual time debt of packets flowing through the network device;
5 and

6 determining whether a packet should be dropped based on the virtual time debt of
7 the packets.

1 29. (Currently Amended): A method of policing packets in a network device, the
2 method comprising the steps of:

3 determining a virtual time debt of packets flowing through the network device,
4 the virtual time debt computed as a positive delay from an expected packet arrival time to
5 an actual packet arrival time; and

6 determining whether a packet should be dropped based on the virtual time debt of
7 the packets.

1 30. (Previously Presented): The method as in claim 29, in the event a packet should be
2 dropped, further comprising:

3 generating a random number;

4 counting a number of packets passing through the network device up to the ran-
5 dom number; and

6 dropping a packet when the counted number reaches the random number.

1 Please Add New Claims 31 *et al.*

1 31. (New): A method of policing packets in a network device, comprising:
2 determining an actual arrival time of a packet;
3 determining a theoretical arrival time of the packet;
4 calculating a virtual time debt in response to the actual arrival time and the theo-
5 retical arrival time;
6 comparing the virtual time debt with a predetermined value;
7 deciding if the virtual time debt exceeds the predetermined value; and
8 generating, in response to the virtual time debt exceeding the predetermined
9 value, a random number that is used to determine which packet should be dropped.

1 32. (New): The method of claim 31, further comprising:

2 using a filter to determine a filtered virtual time debt of a traffic.

1 33. (New): The method of claim 31, further comprising:

2 using a time T in which the packet is expected to arrive; and
3 computing a predetermined output transmission rate.

1 34. (New): The method of claim 33, further comprising:

2 setting the predetermined output transmission rate by a traffic contract.

1 35. (New): The method of claim 32, further comprising:
2 sampling the virtual time debt at a sampling interval; and
3 transmitting the sampled virtual time debt to the filter.

1 36. (New): The method of claim 31, further comprising:
2 using a counter that is set with the number generated by the random number gen-
3 erator;
4 counting packets passing through a RED policer up to the set number;
5 dropping the packet when the counter has counted out the set number.

1 37. (New): The method of claim 31, further comprising:
2 determining a moving average of the virtual time debt; and
3 determining whether a packet should be dropped based on a value of the moving
4 average of the virtual time debt.

1 38. (New): A policer based on Random Early Detection (RED), comprising:
2 an operating system determines an actual arrival time of a packet and a theoretical
3 arrival time of the packet;
4 a control law circuit that calculates a virtual time debt in response to the actual ar-
5 rival time and the theoretical arrival time, compares the virtual time debt with a prede-
6 termined value, and decides if the virtual time debt exceeds the predetermined value; and

7 a random number generator that generates, in response to the virtual time debt ex-
8 ceeding the predetermined value, a random number that is used to determine which
9 packet should be dropped.

1 39. (New): The policer of claim 38, further comprising:
2 a filter that determines a filtered virtual time debt of a traffic.

1 40. (New): The policer of claim 38, further comprising:
2 the virtual time debt uses time T in which the packet is expected to arrive, and is
3 computed using a predetermined output transmission rate.

1 41. (New): The policer of claim 40, further comprising:
2 the predetermined output transmission rate is given by a traffic contract.

1 42. (New): The policer of claim 39, further comprising:
2 a sampler that samples the virtual time debt at a sampling interval and transmits
3 the sampled virtual time debt to the filter.

1 43. (New): The policer of claim 38, further comprising:
2 a counter that is set with the number generated by the random number generator,
3 and counts packets passing through the RED policer up to the set number; and
4 the RED policer drops the packet when the counter has counted out the set num-
5 ber.

- 1 44. (New): The policer of claim 38, further comprising:
 - 2 a filter that determines a moving average of the virtual time debt; and
 - 3 a control law circuit that determines whether a packet should be dropped based on
 - 4 a value of the moving average of the virtual time debt.
- 1 45. (New): An apparatus for policing packets in a network device, comprising:
 - 2 means for determining an actual arrival time of a packet;
 - 3 means for determining a theoretical arrival time of the packet;
 - 4 means for calculating a virtual time debt in response to the actual arrival time and
 - 5 the theoretical arrival time;
 - 6 means for comparing the virtual time debt with a predetermined value;
 - 7 means for deciding if the virtual time debt exceeds the predetermined value; and
 - 8 means for generating, in response to the virtual time debt exceeding the predetermined value, a random number that is used to determine which packet should be dropped.
- 1 46. (New): The apparatus of claim 45, further comprising:
 - 2 means for using a filter to determine a filtered virtual time debt of a traffic.
- 1 47. (New): The apparatus of claim 45, further comprising:
 - 2 means for using a time T in which the packet is expected to arrive; and
 - 3 means for computing a predetermined output transmission rate.
- 1 48. (New): The apparatus of claim 47, further comprising:

2 means for setting the predetermined output transmission rate by a traffic contract.

1 49. (New): The apparatus of claim 46, further comprising:

2 means for sampling the virtual time debt at a sampling interval; and

3 means for transmitting the sampled virtual time debt to the filter.

1 50. (New): The apparatus of claim 45, further comprising:

2 means for using a counter that is set with the number generated by the random
3 number generator;

4 means for counting packets passing through a RED policer up to the set number;

5 means for dropping the packet when the counter has counted out the set number.

1 51. (New): The apparatus of claim 45, further comprising:

2 means for determining a moving average of the virtual time debt; and

3 means for determining whether a packet should be dropped based on a value of
4 the moving average of the virtual time debt.

1 52. (New): A computer readable medium having instructions contained therein, which
2 when executed by a computer performs a method comprising the steps of:

1 determining an actual arrival time of a packet;

2 determining a theoretical arrival time of the packet;

3 calculating a virtual time debt in response to the actual arrival time and the theo-
4 retical arrival time;

5 comparing the virtual time debt with a predetermined value;
6 deciding if the virtual time debt exceeds the predetermined value; and
7 generating, in response to the virtual time debt exceeding the predetermined
8 value, a random number that is used to determine which packet should be dropped.

1 53. (New): Electromagnetic signals propagating on a computer network, the electro-
2 magnetic signals carrying instructions for execution in a processor for the practice of the
3 method comprising the steps of:
4 determining an actual arrival time of a packet;
5 determining a theoretical arrival time of the packet;
6 calculating a virtual time debt in response to the actual arrival time and the theo-
7 retical arrival time;
8 comparing the virtual time debt with a predetermined value;
9 deciding if the virtual time debt exceeds the predetermined value; and
10 generating, in response to the virtual time debt exceeding the predetermined
11 value, a random number that is used to determine which packet should be dropped.